CHAPTER 9

Matched comparison of outcomes following Duhamel and transanal endorectal pull-through procedures in patients with Hirschsprung's disease

Rob J. Meinds[1], Cornelius E.J. Sloots[2], L.W. Ernst van Heurn[3], Marieke J. Witvliet[4],Wim G. van Gemert[5], Ivo de Blaauw[6], Monika Trzpis[7], Paul M.A. Broens[1,7]

1 Department of Surgery, Division of Pediatric Surgery, University Medical Center Groningen, Groningen
2 Department of Pediatric Surgery, Erasmus MC-Sophia Children's Hospital, Rotterdam
3 Department of Pediatric Surgery, Emma Children's Hospital, Amsterdam
4 Department of Pediatric Surgery, Wilhelmina Children's Hospital, Utrecht
5 Department of Pediatric Surgery, Maastricht University Medical Center, Maastricht
6 Department of Pediatric Surgery, Amalia Children's Hospital, Nijmegen
7 Department of Surgery, Anorectal Physiology Laboratory, University Medical Center Groningen, Groningen

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SUMMARY

Background

The majority of Dutch Hirschsprung's disease (HD) patients are operated by either Duhamel or transanal endorectal pull-through (TERPT) procedure. The aim of this study was to perform a sex- and age-matched comparison of the long-term functional outcomes of both procedures.

Methods

From a nationwide cross-sectional study, we selected 52 patients who had underwent a TERPT procedure (mean age 12±2 years) and performed an age- and gender-matched comparison to peers who had underwent a Duhamel procedure and to healthy controls. Functional outcomes were assessed by the Constipation Scoring System (CSS), Continence Grading Scale (CGS). We additionally assessed if surgical approach, *i.e.* laparotomy, laparoscopy or transanal, influenced outcomes.

Results

The median CSS was comparable following Duhamel and TERPT procedures (5 versus 4), but significantly higher compared to controls ($P < .001$). Laxative usage was more frequent following Duhamel procedure compared to TERPT procedure (48% versus 12%, $P < .001$). The CGS was comparable following either procedure (4 versus 5), but significantly greater than in controls ($P = .003$ and $P < .001$). Compared to open Duhamel procedures, laparoscopic procedures resulted in significant lower laxative usage ($P = .017$) and soiling ($P = .007$). TERPT procedures that were performed transanal resulted in higher prevalences of urge incontinence for feces ($P < .001$) and urine ($P = .006$), compared to laparoscopic procedures.

Conclusions

The differences in functional outcomes following Duhamel and TERPT procedures are limited. Duhamel procedure outcomes can be further improved by opting for laparoscopy instead of an open approach, whereas TERPT outcomes can be improved when performed laparoscopically, instead of completely transanal.

INTRODUCTION

Hirschsprung's disease (HD) is a congenital condition of the distal intestines characterized by absence of ganglion cells and intractable constipation. Because of the severity of constipation, the vast majority of HD patients require a surgical procedure to resect the affected intestines.

In the majority of Dutch HD patients, the resection of affected intestines is done by either Duhamel or transanal endorectal pull-through (TERPT) procedure.[1,2] The Duhamel procedure constructs a new rectal pouch by a posterior side-to-side anastomosis of aganglionic rectum and ganglionic intestines,[1] whereas the TERPT procedure consists of a transanal pull-through of ganglionic intestines followed by a very low direct anastomosis just above the dentate line.[2] The latter can be done using a short aganglionic muscular cuff by a transanal submucosal dissection (*i.e.* Soave-like)[2,3] or by a full-thickness dissection of the bowel wall (*i.e.* Swenson-like).[4]

Both Duhamel and TERPT procedures have been compared before, albeit with small heterogeneous groups and inconclusive results.[5–9] The general consensus, however, is that both procedures have their advantages and downsides.[10] Firstly, the retrorectal approach of the Duhamel procedure is thought to avoid the nerves located anterior of the rectum, thus limiting iatrogenic nerve damage. In turn, there may be increased constipation complaints because of the residual aganglionic rectum. Secondly, the TERPT procedure can be performed completely transanal, thus reducing the chance of post-operative adhesions by avoiding extensive manipulation in the peritoneal cavity and resulting in better cosmetic results since less scar tissue will be seen on the abdominal wall.[3,9] However, there have been concerns that this approach may have an increased risk of anal sphincter damage by overt stretching during the procedure.[11,12]

Because of the heterogeneity of previous studies,[5–9] we decided to perform a gender- and age-matched analysis on the long-term outcomes of both techniques. Given the nature of both procedures, we hypothesize that there may be an increased severity of fecal incontinence following the TERPT procedure because of overstretching of the anal sphincter, whereas the Duhamel procedure may be followed by an increased tendency towards constipation because of the residual aganglionic rectum. The aim of this study was to perform a matched comparison of the long-term functional outcomes of both procedures, concerning constipation, fecal continence, and urinary continence.

METHODS

Study design

We recently performed a nationwide cross-sectional study of the long-term outcomes in HD in collaboration with six pediatric surgery centers.[13] For this study, we analyzed the medical records of all known HD patients born between 1955 and 2009, which resulted in a data base consisting of 830 HD patients. Following the exclusion of ineligible patients (for example passed away, permanent stoma, intellectual disability, no known address), we invited 619 patients and their parents or caregivers to participate and complete questionnaires on anorectal functioning and quality of life. Following this invitation, a total of 389 (55.2%) responded and completed questionnaires. For our current study, we included 52 pediatric respondents who had undergone a TERPT procedure. These were matched on sex and age to 52 pediatric respondents who had underwent a Duhamel procedure.

These two groups were compared on variables such as age at time of surgery, surgical approach (laparotomy, laparoscopy, or transanal), surgical complications, post-operative enterocolitis, and additional treatments (for example, sphincterectomy, dilatation, botulinium injection, or redo pull-through). Surgical complications were defined as complications that occurred within 30 days of and that were the direct result of the initial surgical intervention (for example, anastomotic leakage, wound infection, adhesions). Post-operative enterocolitis was defined as the presence of symptoms such as abdominal distention, diarrhea, bloody stools, and/or fever with the intention-to-treat as such.[14]

Next, we additionally matched 52 healthy controls on age and gender that we randomly selected from a previous study we conducted in the Dutch general population,[15] thus resulting in three comparable groups. Using the questionnaire data, we then assessed functional outcomes and urinary continence in the three groups.

Differences in surgical procedures and follow-up

There was a variation in surgical procedures performed in the six participating surgical centers. The Duhamel procedure was performed in center A (n = 33), center B (n = 9), and center C (n = 10). The TERPT procedure was performed with a transanal submucosal dissection (*i.e.* Soave-like) in center D (n = 11), center E (n = 7), center B (n = 5), and center C (n = 2), whereas it was performed with a full-thickness dissection (*i.e.* Swenson-like) in center F (n = 27). In each surgical center, a maximum of three pediatric surgeons is responsible for carrying out or supervising the surgical treatment of HD.

Aside from surgical preferences, the remainder of the treatment and follow-up of HD patients in the Netherlands have been standardized following a collaboration between

all six pediatric surgical centers and the national patient association.[16] This healthcare standard guarantees a comparable and sufficient follow-up for all HD patients in the Netherlands.

Assessment of functional outcomes

The functional outcomes were assessed using patients' answers on the anorectal functioning questionnaire (P-DeFeC questionnaire).[17]

The severity of constipation was assessed by the Constipation Scoring System (CSS) by Agachan and colleagues.[18] The CSS consists of 8 items totaling a score between 0 and 30 points, for which 0 is no constipation and 30 is extreme constipation. Items include defecation frequency, painful evacuation, incomplete defecation, abdominal pain, time on lavatory, need for assistance, failure to evacuate, and duration of constipation. Using the questionnaire, we additionally scored the use of laxatives, rectal suppositories, and the need for rectal irrigation as therapy for constipation, all had to be used at least several times per month.

The severity of fecal incontinence was assessed by the Continence Grading Scale (CGS) by Jorge and colleagues,[19] where a score of 0 implies perfect continence and 20 complete incontinence. The CGS consists of 5 items, including incontinence for solid stool, incontinence for liquid stool, incontinence for gas, need to wear pads, and lifestyle alterations. We additionally looked at several subtypes of fecal incontinence, of which all had to occur at least multiple times per month. Soiling was defined as the loss of small amounts of feces or staining of underwear, urge incontinence as being unable to reach the toilet in time after feeling of urge, incontinence for liquid stool as loss of watery stools or diarrhea, and incontinence for solid stool as loss of large amounts of solid feces without having felt urge. Using the questionnaire, we additionally scored the need for rectal irrigation as therapy for fecal incontinence.

Lastly, we assessed anorectal sensations, that is the ability to feel urge and the ability to differentiate types of stool.

Assessment of urinary continence

In the DeFeC questionnaire a section on urinary incontinence was included. Based on the answers given by patients, we defined stress incontinence as involuntary urine loss upon effort, coughing, sneezing, or exertion. Urge incontinence was defined as the involuntary loss of urine prior to reaching the toilet. Nightly incontinence was defined as the involuntary loss of urine while asleep. Post-micturition dribble was defined as the loss of urine while getting dressed after urinating. Lastly, involuntary loss for no clear reason or continuously was defined as such.

Statistical analysis

Data were analyzed using SPSS 23.0 for Windows (IBM SPSS Statistics, IBM Corporation, Armonk, NY). Proportions were reported as prevalence percentages. Continuous variables were reported as median with minimum and maximum or as mean with standard deviation (SD), depending on the normality of distribution. The statistical tests that were used were limited to Pearson's chi-square test, Mann-Whitney U-test, and Students' t test which were used appropriately. Two-sided *P* values of less than .050 were considered statistically significant.

Table 1 Patient and clinical characteristics

	Duhamel No. (%)	TERPT No. (%)	*P* value
Overall	52 (100)	52 (100)	
Patient characteristics			
Male sex	46 (88)	46 (88)	1.000
Age at follow-up (years)[a]	13 ± 2	12 ± 2	.195
Length of aganglionosis			.315
Rectosigmoid	45 (87)	46 (88)	
Long segment	3 (6)	5 (10)	
Total colonic	4 (8)	1 (2)	
Congenital comorbidities	5 (10)	6 (12)	.750
Clinical characteristics			
Age at time of surgery (days)[b]	135 (8 – 1867)	148 (15 – 1333)	.782
Surgical approach			< .001
Laparotomy	41 (79)	1 (2)	
Laparoscopy	11 (21)	40 (77)	
Transanal	0 (0)	11 (21)	
Surgical complication	7 (13)	2 (4)	.081
Post-operative enterocolitis	12 (23)	8 (15)	.320
Additional treatments			
Anal sphincterectomy	1 (2)	0 (0)	.315
Anal dilatation	2 (4)	8 (15)	.046
Anal botulinium injection	6 (12)	6 (12)	1.000
Redo pull-through	4 (8)	6 (12)	.506

[a] Mean ± SD

[b] Median (minimum – maximum)

RESULTS

Patient and clinical characteristics

A total of 104 patients who had undergone Duhamel (n = 52) or TERPT procedure (n = 52) were included. Patient characteristics are listed in Table 1. Following matching, there were no significant differences in the distribution of sex, mean age, length of aganglionosis, and comorbidities between the two groups (Table 1). The majority (79%) of the Duhamel procedures were performed using laparotomy, while TERPT was primarily performed laparoscopy-assisted (77%, $P < .001$) (Table 1). Moreover, patients treated by TERPT procedure more often underwent anal dilation compared to patients treated by Duhamel procedure (15% versus 4%, $P = .046$, Table 1).

Comparison of functional outcomes

The severity of constipation, assessed by the CSS, was comparable in patients treated by either procedure, whereas it was significantly higher in both groups of patients compared to healthy controls ($P < .001$, Table 2). With regards to therapy usage for constipation, nearly half (48%) of the Duhamel group reported using laxatives at least several times per month, compared to only 12% in the TERPT group ($P < .001$, Table 2). The usage of rectal suppositories was comparable in both groups of patients and controls (Table 2). Rectal irrigation for constipation was comparable in both groups of patients (11% versus 11%), but significantly higher when compared to controls (0%, $P < .001$, Table 2).

There was no difference in the severity of fecal incontinence, assessed by the CGS, between patients treated by either procedure. However, the severity of fecal incontinence was significantly greater in patients treated by either Duhamel (median score 4) or TERPT procedure (median score 5) compared to controls (median score 2, $P = .003$ and $P < .001$, respectively, Table 2). Soiling was the most common type of fecal incontinence in both groups of patients, with a prevalence of 35% following Duhamel procedure and 42% following TERPT procedure. There were no differences in the prevalence of subtypes of fecal incontinence between patients treated by either procedure (Table 2). Rectal irrigation for the treatment of fecal incontinence was comparable in the Duhamel and TERPT group (12% versus 13%), and significantly higher compared to controls (0%, $P = .036$ and $P = .019$, respectively, Table 2).

Next, we compared anorectal sensation, i.e. the ability to feel urge and ability to differentiate types of stool (Figure 1). There was no difference in the ability to feel urge between patients treated by Duhamel or TERPT procedure. Controls, however, significantly more often felt urge compared to patients treated by Duhamel ($P = .001$) and TERPT procedure ($P = .003$) (Figure 1A). The ability to differentiate types of stool (Figure

1B) were not significantly different between the three groups.

Comparison of urinary continence

There were no differences in the prevalences of any subtype of urinary incontinence between the groups of patients treated by Duhamel and TERPT procedure (Table 2). However, compared to healthy controls, patients who had underwent a Duhamel procedure suffered significantly more often from continuous urinary incontinence (10% versus 0%, P = .022, Table 2). Following TERPT procedure, patients suffered significantly more often from nightly urinary incontinence (13%, P = .027) and continuous urinary incontinence (8%, P = .041) compared to healthy controls (Table 2).

Comparison of Duhamel approaches

We additionally compared the outcomes of Duhamel procedures that were performed using laparotomy (*i.e.* open Duhamel, n = 41) and the Duhamel procedures that were performed using laparoscopy (*i.e.* laparoscopic Duhamel, n = 11) (Table 3). Importantly, there were no differences in distribution of sex, age, or length of aganglionosis between the two Duhamel approaches (Table 3). The severity of constipation, as indicated by the CSS score, and the severity of fecal incontinence, as indicated by the CGS score,

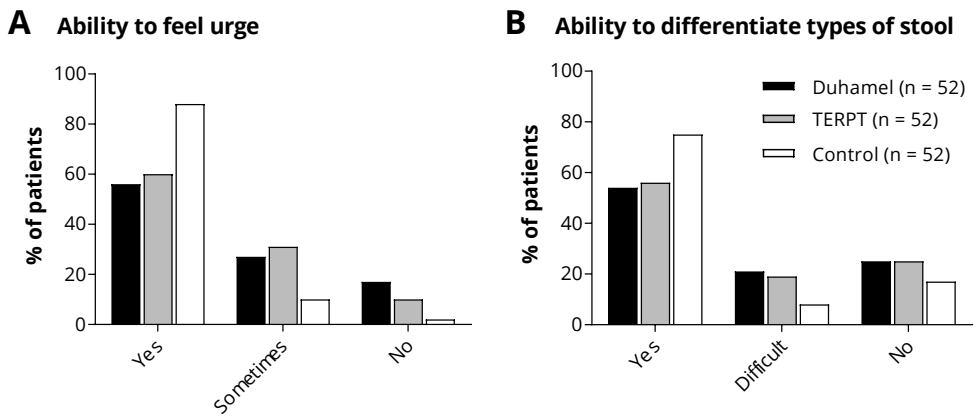

Figure 1

Comparison of anorectal sensation.

A: There was no difference in the feeling of urge between patients treated by Duhamel or TERPT procedure. Controls significantly more often felt urge compared to patients treated by Duhamel (P = .001) and TERPT procedure (P = .003).

B: The ability to differentiate types of stool was comparable between the three groups (no significant differences).

Table 2
Comparison of functional outcomes

	Duhamel (n = 52), No. (%)	TERPT (n = 52), No. (%)	Controls (n = 52), No. (%)	*P* values		
	A	B	C	A vs B	A vs C	B vs C
Constipation						
CSS (median, range)	5 (1 – 20)	4 (0 – 15)	2 (0 – 9)	.293	< .001	< .001
Laxative usage	25 (48)	6 (12)	1 (2)	< .001	< .001	.050
Rectal suppository usage	2 (4)	2 (4)	0 (0)	1.000	.153	.153
Rectal irrigation for constipation	11 (21)	11 (21)	0 (0)	1.000	< .001	< .001
Fecal continence						
CGS (median, range)	4 (0 – 15)	5 (0 – 12)	2 (0 – 8)	.359	.003	< .001
Soiling	18 (35)	22 (42)	4 (8)	.420	.001	< .001
Urge incontinence	4 (8)	4 (8)	1 (2)	1.000	.169	.169
Incontinence for solid stool	6 (12)	3 (6)	1 (2)	.295	.050	.308
Incontinence for liquid stool	7 (13)	3 (6)	0 (0)	.183	.006	.079
Rectal irrigation for incontinence	6 (12)	7 (13)	0 (0)	.767	.036	.019
Urinary continence						
Stress incontinence	2 (4)	1 (2)	4 (8)	.558	.400	.169
Urge incontinence	2 (4)	2 (4)	0 (0)	1.000	.153	.153
Nightly incontinence	6 (12)	7 (13)	1 (2)	.767	.050	.027
Post-micturition dribble	1 (2)	0 (0)	2 (4)	.315	.558	.153
Continuous or no clear cause	5 (10)	4 (8)	0 (0)	.727	.022	.041

TERPT = Transanal endorectal pull-through, CSS = Constipation Scoring System, CGS = Continence Grading Scale

was comparable following both approaches (Table 3). Compared to open Duhamel procedures, patients treated laparoscopically had a significantly lower usage of laxatives (59% versus 18%, *P* = .017), and had a lower prevalence of soiling (44% versus 0%, *P* = .007) (Table 3). The rest of the tested variables were comparable in the two approaches (Table 3).

Table 3
Comparison of Duhamel approaches

	Open Duhamel (n = 41), No. (%)	Laparoscopic Duhamel (n = 11), No. (%)	*P* value
Patient characteristics			
Male sex	37 (90)	9 (82)	.437
Age (median, range)	13 (9 – 19)	13 (9 – 16)	.821
Rectosigmoid variant	37 (90)	8 (73)	.277
Constipation			
CSS (median, range)	5 (1 – 19)	5 (1 – 20)	.398
Laxative usage	24 (59)	2 (18)	.017
Rectal suppository usage	2 (5)	0 (0)	.455
Rectal irrigation for constipation	9 (22)	2 (18)	.786
Fecal continence			
CGS (median, range)	4 (1 – 15)	2 (0 – 15)	.175
Soiling	18 (44)	0 (0)	.007
Urge incontinence	4 (10)	0 (0)	.281
Solid stool incontinence	6 (15)	0 (0)	.177
Liquid stool incontinence	7 (17)	0 (0)	.141
Rectal irrigation for incontinence	5 (12)	1 (9)	.775
Urinary continence			
Stress incontinence	2 (5)	0 (0)	.455
Urge incontinence	2 (5)	0 (0)	.445
Nightly incontinence	5 (12)	1 (9)	.775
Post-micturition dribble	1 (2)	0 (0)	.601
Continuous or no clear cause	4 (10)	1 (9)	.947

CSS = Constipation Scoring System, CGS = Continence Grading Scale

Comparison of TERPT approaches

Next, we compared the outcomes of TERPT procedures that were performed using laparoscopy (*i.e.* laparoscopic TERPT, n = 40) with the TERPT procedures that were performed completely transanal (*i.e.* transanal TERPT, n = 11) (Table 4). There were no significant differences in sex, age, and length of aganglionosis between the two TERPT approaches (Table 4). There were no significant differences in the severity of constipation

Table 4
Comparison of TERPT approaches

	Laparoscopic TERPT (n = 40), No. (%)	Transanal TERPT (n = 11), No. (%)	*P* value
Patient characteristics			
Male sex	35 (88)	10 (91)	.756
Age (median, range)	13 (8 – 17)	12 (10 – 14)	.342
Rectosigmoid variant	35 (88)	11 (100)	.467
Constipation			
CSS (median, range)	4 (0 – 15)	3 (0 – 10)	.954
Laxative usage	4 (10)	2 (18)	.456
Rectal suppository usage	2 (5)	0 (0)	.449
Rectal irrigation for constipation	8 (20)	3 (27)	.603
Fecal continence			
CGS (median, range)	4 (0 – 12)	6 (2 – 11)	.076
Soiling	15 (38)	6 (55)	.309
Urge incontinence	0 (0)	4 (36)	< .001
Solid stool incontinence	1 (3)	2 (18)	.050
Liquid stool incontinence	1 (3)	2 (18)	.050
Rectal irrigation for incontinence	4 (15)	3 (30)	.295
Urinary continence			
Stress incontinence	0 (0)	1 (9)	.054
Urge incontinence	0 (0)	2 (18)	.006
Nightly incontinence	4 (10)	2 (18)	.456
Post-micturition dribble	0 (0)	0 (0)	
Continuous or no clear cause	2 (5)	2 (18)	.150

TERPT = Transanal endorectal pull-through, CSS = Constipation Scoring System, CGS = Continence Grading Scale

and fecal incontinence, as indicated by CSS and CGS score, respectively, following both TERPT approaches (Table 4). However, patients treated by a completely transanal TERPT procedure had significantly higher prevalences of urge incontinence for feces (36% versus 0%, $P < .001$) and urine (18% versus 0%, $P = .006$), compared to patients treated by laparoscopic TERPT. The rest of the tested variables were not significantly different between the two approaches (Table 4).

DISCUSSION

In contrast to what we hypothesized, there were no significant differences in the severity of constipation and fecal incontinence following Duhamel and TERPT procedures. The higher usage of laxatives in the total group of Duhamel procedures may be an indication of a greater tendency towards constipation in this group. Nevertheless, we showed that this may be negated by performing a laparoscopic Duhamel procedure, following which the usage of laxatives was significantly lower. Last, our results showed that patients who underwent a completely transanal TERPT procedure had significant higher prevalences of urge incontinence for both feces and urine compared to patients who underwent a laparoscopic TERPT procedure.

With regards to long-term functional outcomes, there is currently little evidence that substantiates the decision to prefer either technique over the other. Multiple studies have compared the outcomes of Duhamel and TERPT procedures, often with varying results, and often based on small heterogeneous patient groups.[5–8] A major flaw in these studies is the difference in age between the two compared groups, resulting from the use of patients from different time cohorts, and subsequently biasing results. A recent meta-analysis by Chen and colleagues therefore concluded that the current quality of evidence is too low to draw any conclusions on the comparison of functional outcomes following both techniques.[9] We therefore performed a sex- and age-matched comparison of patients operated with both techniques, limiting bias by these factors, which showed that the differences between both techniques, if any, are small. The only notable difference between both techniques was the higher usage of laxatives following the Duhamel procedure. First, this difference may result from differences between healthcare providers and surgical centers, whereby some may be faster inclined to prescribe laxatives than others. Second, the difference in laxative usage may result from structural differences in both surgical techniques. This line of reasoning is supported by the postulation that the pouch created in the Duhamel procedure, partially consisting of native aganglionic rectum, may continue to impair bowel function, thus leading to an increased tendency to constipation.[20] In any case, this difference between Duhamel and

TERPT procedure may be negated by performing a laparoscopic Duhamel procedure, following which the usage of laxatives was significantly lower.

Contrary to what we hypothesized, there was no significant difference in the prevalence of fecal incontinence, nor in the prevalence of urinary incontinence, following Duhamel or TERPT procedure. It therefore seems that the potential iatrogenic nerve damage is not necessarily greater following TERPT procedure. Importantly, we found that both fecal and urinary continence may be further improved by avoiding the completely transanal approach during TERPT procedure, and instead opting for assisting the TERPT with laparoscopy. This contradicts a previous meta-analysis by Thomson and colleagues[21] which found no differences between the two approaches. It must be noted however, that all the included studies were retrospective case studies and that the authors of the meta-analysis themselves concluded that the overall quality of studies was low. There may be several reasons for the difference in continence following both TERPT approaches. First, the completely transanal TERPT approach may be troubled by a limited, or even absent, view of the pelvic anatomic structures. The reduced view may increase the risk of iatrogenic pelvic nerve damage, thus resulting in a higher risk of impaired continence. Second, impaired continence may result from a prolonged stress on the anal sphincter during the completely transanal approach. Based on these results, it is unfortunately not possible to differentiate between the two aforementioned reasons. Possible future studies should therefore include extensive anorectal manometric investigations, allowing the comparison of anal sphincter functioning between patients treated by either TERPT approach. A last argument for performing the TERPT procedure in combination with laparoscopy is that it allows for a more precise assessment of the transitional zone, as this has been proven to be difficult to predict pre-operatively.[22]

Certain limitations, as well as strengths, should be taken into account before drawing conclusions. First, because multiple surgical centers participated, there may have been a variation in post-operative treatment and follow-up. We believe these differences were limited, as the care of HD has been nationally standardized following a collaboration between the six surgical centers and the national patient association,[16] guaranteeing a minimal level of care for all HD patients. Second, another limitation of this study may be the difference in TERPT procedures, of which nearly half was performed Soave-like, while the rest was performed Swenson-like. We have decided to group these patients together as a previous report has shown that the two techniques are comparable.[23] This reasoning was confirmed by the outcomes of our own subanalyses, which showed no significant differences in any of the tested variables between Swenson-like and Soave-like TERPT procedures, after the exclusion of the completely transanal TERPT procedures (data not shown). Meanwhile, a strength of this study was the number of investigated variables,

including clinical aspects such as complications and episodes of enterocolitis, as well as long-term functional outcomes, including urinary continence. Lastly, the major strength of this study over previous studies on the same subject is that we performed a gender- and age-matched analysis. This has resulted in two comparable groups of patients, of the same age, and with comparable lengths of follow-up, wherein the only difference was the type of surgical procedure.

Conclusions

In conclusion, the differences in functional outcomes following Duhamel and TERPT procedures, if any, are small. Importantly, the outcomes of the Duhamel procedure can be further improved by opting for laparoscopy instead of an open approach, whereas the outcomes of the TERPT procedure can be improved by assisting the procedure with laparoscopy, instead of performing it completely transanal.

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